

Claims

1. A power generation apparatus comprising a fuel cell and a reforming module, wherein the reforming module is adapted to reform hydrocarbon fuel into hydrogen and other components, and to separate said hydrogen from said other components, the apparatus being arranged so that said hydrogen is fed from the reforming module to the anode of the fuel cell.
2. Apparatus as claimed in claim 1, wherein the apparatus is arranged such that substantially no carbon dioxide is fed to the fuel cell with the hydrogen.
3. Apparatus as claimed in claim 1 or 2, wherein the apparatus is arranged such that substantially nothing except hydrogen is fed to the fuel cell.
4. Apparatus as claimed in any preceding claim, comprising means for recycling hydrogen in the outflow stream of the anode of the fuel cell back to the anode.
5. Apparatus as claimed in claim 4 comprising means for controlling the amount of hydrogen recycled
6. Apparatus as claimed in claim 4 or 5 comprising means for tapping off hydrogen that is not recycled.
7. Apparatus as claimed in any preceding claim, comprising means for removing water from the outflow stream of the anode of the fuel cell.
8. Apparatus as claimed in any preceding claim,

- wherein the reforming module is adapted to fuel selected from the group comprising natural gas, methane, methanol, diesel, gasoline, coal, biomass, gases from the gasification of organic matter such as biomass or carbons/hydrocarbons, gases from the biological decomposition of organic matter such as biomass or carbons/hydrocarbons, and gas-hydrates.
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9. Apparatus as claimed in any preceding claim, wherein the reforming module comprises means for separating carbon dioxide.
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10. Apparatus as claimed in any preceding claim, wherein the reforming module comprises means for outputting a stream of said carbon dioxide.
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11. Apparatus as claimed in any of claims 1 to 9, wherein the reforming module comprises means for absorbing carbon dioxide or sequestering it into a solid.
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12. Apparatus as claimed in claim 11, wherein the reforming module comprises means for absorbing the carbon dioxide by a carbonation reaction with a metal oxide to produce a metal carbonate.
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13. Apparatus as claimed in claim 11 or claim 12, wherein the reforming module comprises means for absorbing the carbon dioxide by a carbonation reaction with a metal hydroxide to produce a metal carbonate.
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14. Apparatus as claimed in any preceding claim which also comprises a desorption module adapted to allow the release of carbon dioxide.

15. Apparatus as claimed in claim 14 wherein the desorption module is adapted to allow the release of carbon dioxide from a metal carbonate.
- 5 16. Apparatus as claimed in claim 15 wherein the desorption module is adapted to allow the release of carbon dioxide from calcium carbonate.
- 10 17. Apparatus as claimed in any preceding claim, wherein the reforming module is thermally integrated with the fuel cell.
- 15 18. Apparatus as claimed in claim 17, comprising heat transfer means between the fuel cell and reforming module in the form of a cathode exhaust loop.
- 20 19. Apparatus as claimed in any of claims 14 to 18, wherein the desorption module is thermally integrated with the fuel cell.
- 25 20. Apparatus as claimed in any of claims 14 to 19 comprising means for switching flow to the reforming module to the desorption module and/or flow to the desorption module to the reforming module.
- 30 21. Apparatus as claimed in any preceding claim, wherein the fuel cell is a Polymer Electrolyte Membrane fuel cell, Phosphoric Acid fuel cell or Solid Oxide fuel cell.
- 35 22. A method of operating a fuel cell, comprising recycling hydrogen from the anode outflow back to the anode inlet, such that the fuel cell has a minimum cell operating voltage of 0.8 volts.

23. A method of operating a fuel cell, comprising recycling hydrogen from the anode outflow back to the anode inlet, such that the molar ratio of hydrogen to water in the anode outflow is greater than 0.5.
24. A method of generating electrical power using an apparatus as claimed in any of claims 1 to 21.
25. A method of generating power and producing hydrogen using an apparatus as claimed in any of claims 1 to 21.
26. A method of operating an apparatus as claimed in any of claims 1 to 21, comprising condensing water from the anode exhaust stream and recycling all of the hydrogen in the resultant stream back to the anode of the fuel cell.
27. A method of operating an apparatus as claimed in any of claims 1 to 21, comprising condensing water from the anode exhaust stream and tapping off all of the hydrogen in the resultant stream for use elsewhere.
28. A method of operating an apparatus as claimed in any of claims 1 to 21, comprising condensing water from the anode exhaust stream and recycling a portion of the hydrogen in the resultant stream back to the anode of the fuel cell and further comprising tapping off the remainder of the hydrogen for use elsewhere.
29. A method as claimed in any of claims 26 to 28, wherein the molar ratio of hydrogen to water in the anode outflow is greater than 0.5.

30. A power generation apparatus comprising a fuel cell, a reforming module and a desorption module, wherein the reforming module is adapted to reform hydrocarbon fuel into hydrogen and carbon dioxide, to separate said hydrogen from said carbon dioxide, and to absorb said carbon dioxide by a carbonation reaction with a metal oxide to produce a metal carbonate, and the desorption module is adapted to allow the release of carbon dioxide from a metal carbonate, the apparatus being arranged so that said hydrogen is fed from the reforming module to the anode of the fuel cell.
31. A power generation apparatus comprising a fuel cell and a reforming module, wherein the reforming module is adapted to reform hydrocarbon fuel into hydrogen and other components, and to separate said hydrogen from said other components, the apparatus being arranged so that said hydrogen is fed from the reforming module to the anode of the fuel cell; the apparatus also comprising means for recycling hydrogen in the outflow stream of the anode of the fuel cell back to the anode, means for controlling the amount of hydrogen recycled, and means for tapping off hydrogen that is not recycled.